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(54) **POROUS POLYTETRAFLUOROETHYLENE FILM, METHOD FOR PRODUCTION THEREOF, AND WATER-PROOF BREATHABLE FILTER**

(57) First, a first porous body is manufactured by stretching, in a uniaxial direction, a sheet made of polytetrafluoroethylene having a standard specific gravity of 2.155 or more, and a second porous body is manufactured by stretching, in biaxial directions, a sheet made of polytetrafluoroethylene. Next, the first porous body is integrated with the second porous body by stretching a laminate of the first porous body and the second porous body in the same direction as the uniaxial direction while heating the laminate at a temperature equal to or higher than a melting point of polytetrafluoroethylene. Thus, a porous polytetrafluoroethylene membrane is produced.

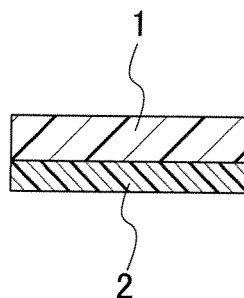


FIG.1A

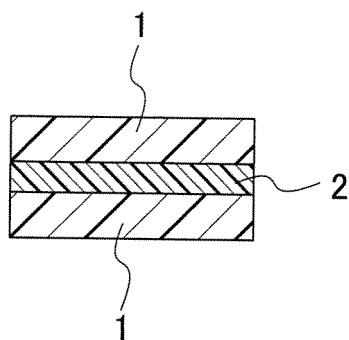


FIG.1B

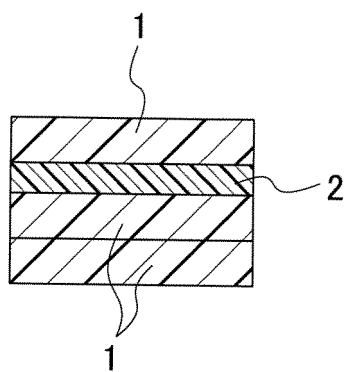


FIG.1C

Description

TECHNICAL FIELD

[0001] The present invention relates to a porous polytetrafluoroethylene (hereinafter referred to as "PTFE") membrane and a method for producing the membrane, and a water-proof air permeable filter.

[0002] Conventionally, water-proof air permeable filters have been used, for example, for automobile electrical components, office automation apparatuses, household electrical appliances, and medical equipment in order to eliminate a pressure difference between the inside and outside of a housing accommodating electronic parts, control boards, etc. The water-proof air permeable filter is attached to the housing so as to close an opening of the housing. The water-proof air permeable filter serves to provide protection against dust and water while ensuring air permeability. In such a water-proof air permeable filter, a porous PTFE membrane with a satisfactory air permeability and high water pressure resistance commonly is used.

[0003] Since the PTFE porous membrane has a small thickness, the water-proof air permeable filter usually is formed by laminating a support material, such as a nonwoven fabric, with the porous PTFE membrane (see JP11 (1999)-58575 A, for example). To attach the water-proof air permeable filter to a housing, the support material is welded to the housing.

[0004] Nowadays, the water-proof air permeable filter is required to have heat resistance when used in some automobile components and sensors, for example. However, since many nonwoven fabrics have a poor heat resistance, there is a demand to fabricate the water-proof air permeable filter with a high heat resistance porous PTFE membrane alone, and weld the porous PTFE membrane directly to the housing. In order to meet this demand, it is necessary to increase the thickness of the porous PTFE membrane and ensure the strength.

[0005] Generally, it is possible to obtain a porous PTFE membrane with a thickness of 200 μm to 300 μm by stretching an unsintered thick PTFE sheet only in a uniaxial direction to make it porous. However, merely increasing the thickness of the porous PTFE membrane in this way lowers the air permeability of the membrane. In order to increase the air permeability, it is conceivable to increase the stretching factor of the sheet, but this lowers the water pressure resistance.

DISCLOSURE OF INVENTION

[0006] In view of these circumstances, the present invention is intended to provide a method for producing a porous PTFE membrane with a high air permeability and water pressure resistance as well as a large thickness, a porous PTFE membrane produced by this production method, and a water-proof air permeable filter including the porous PTFE membrane.

[0007] The inventor of the present invention focuses his attention to the fact that porous PTFE membranes used for air filters for clean rooms, etc. have a high air permeability and water pressure resistance. Such a porous PTFE membrane for filters is obtained by stretching an unsintered PTFE sheet in biaxial directions to make it porous. However, the membrane has an extremely small thickness, and it has not been considered for eliminating the pressure difference. Hence, the inventor considered to fabricate a porous PTFE membrane by stacking a porous body manufactured by stretching a sheet made of PTFE in a uniaxial direction on a porous body manufactured by stretching a sheet made of PTFE in biaxial directions. More specifically, the inventor considered to ensure the thickness of the porous PTFE membrane by using a porous body manufactured by stretching a sheet in a uniaxial direction, and to ensure the water pressure resistance of the membrane by using a porous body manufactured by stretching a sheet in biaxial directions.

[0008] However, when a porous PTFE membrane with such a configuration was produced from conventionally used PTFE, a satisfactory air permeability was not achieved. As a result of intensive studies, the inventor has found that a porous body with a high air permeability can be obtained when a resin with a relatively low molecular weight is used.

[0009] The present invention has been accomplished in view of the foregoing. The present invention provides a method for producing a porous PTFE membrane, including the steps of: manufacturing a first porous body by stretching, in a uniaxial direction, a sheet made of PTFE having a standard specific gravity, which is a measure for molecular weight, of 2.155 or more; manufacturing a second porous body by stretching, in biaxial directions, a sheet made of PTFE; and integrating the first porous body with the second porous body by stretching a laminate of the first porous body and the second porous body in the same direction as the uniaxial direction while heating the laminate at a temperature equal to or higher than a melting point of PTFE.

[0010] The standard specific gravity, which is also referred to as SSG, is a specific gravity measured by a physical measuring method prescribed by JIS K6892. The standard specific gravity is in an inverse relation to molecular weight (the standard specific gravity shows a negative correlation to molecular weight.)

[0011] The present invention further provides a porous PTFE membrane with a laminated structure, having a thickness in the range of 70 μm to 400 μm , an air permeability in the range of 2 seconds/100mL to 40 seconds/100mL in terms of Gurley number, and a water pressure resistance in the range of 40 kPa to 300 kPa.

[0012] The present invention further provides a water-proof air permeable filter including a porous base material for

preventing entry of water while ensuring air permeability. The base material is composed of the above-mentioned porous PTFE membrane.

[0013] In the present invention, the first porous body can ensure the thickness of the porous PTFE membrane, and the second porous body can ensure the water pressure resistance of the porous PTFE membrane. Moreover, since the first porous body is manufactured by stretching, in a uniaxial direction, a sheet made of PTFE having a standard specific gravity of 2.155 or more, it is possible to obtain a porous PTFE membrane with a satisfactory air permeability even when stacking the first porous body on the second porous body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figs. 1A to 1C are cross-sectional views of porous PTFE membranes according to one embodiment of the present invention.

Fig. 2A is a plan view of a water-proof air permeable filter obtained by forming an adhesive layer on the porous PTFE membrane shown in Fig. 1B, and Fig. 2B is a cross-sectional view of the water-proof air permeable filter.

BEST MODE FOR CARRYING OUT THE INVENTION

[0015] Hereafter, the method for producing the porous PTFE membrane of the present invention will be described. This production method is a method for obtaining a porous PTFE membrane with a laminated structure, composed of a first porous body 1 and a second porous body 2 as shown in Fig. 1A to Fig. 1C. The production method includes three steps from a first step to a third step.

[0016] In the first step, an unsintered tape-shaped first sheet is stretched only in a uniaxial direction that is its longitudinal direction while being heated appropriately to manufacture the first porous body with a thickness of at least 50 μm but not more than 200 μm .

[0017] The first sheet is made of PTFE having a standard specific gravity of 2.155 or more. Examples of such PTFE include the following produced by different companies.

<PTFEs produced by Asahi Glass Co., Ltd.>

Product name	Standard specific gravity	Number-average molecular weight according to the company
Fluon CD-014	2.20	2 millions
Fluon CD-1	2.20	2 millions
Fluon CD-145	2.19	8 millions
Fluon CD-123	2.155	12 millions

<PTFEs produced by Daikin Industries Ltd.>

Product name	Standard specific gravity	Number-average molecular weight according to the company
Polyflon F104	2.17	6 millions
Polyflon F106	2.16	Not available

<PTFEs produced by Dupont-Mitsui Fluorochemicals Co., Ltd.>

Product name	Standard specific gravity	Number-average molecular weight according to the company
Teflon 6-J	2.21	Not available
Teflon 65-N	2.16	Not available

[0018] Preferably, the stretching factor is at least 2 but not more than 15 as a common-sense factor for achieving the porosity of the first sheet by stretching it. This is because a factor of 15 or more makes it difficult to obtain the first porous body with a large thickness.

[0019] The temperature at which the stretching is performed preferably is 200°C or higher, and more preferably 250°C or higher. Preferably, it is lower than the melting point of PTFE. This is because when the stretching is performed at a temperature equal to or higher than the melting point of PTFE, a surface of the first porous body is sintered, affecting the integration of the first porous body with the second porous body to be described later.

[0020] In the second step, an unsintered tape-shaped second sheet is stretched in biaxial directions that are its longitudinal direction and width direction while being heated appropriately to manufacture the second porous body with

a thickness of at least 10 μm but not more than 100 μm .

[0021] The second sheet is made of PTFE. The PTFE is not particularly limited, and various commercially-available PTFEs can be used. For example, PTFE having a standard specific gravity of less than 2.155, such as F101HE (having a standard specific gravity of 2.143) produced by Daikin Industries Ltd. may be used. According to the company, F101HE

[0022] The second sheet is stretched in the longitudinal direction first, and then stretched in the width direction. The stretching factor in the longitudinal stretching preferably is at least 4 but not more than 20. The stretching factor in the width direction stretching preferably is at least 5 but not more than 50.

[0023] As the temperature at which the longitudinal stretching is performed, 200°C or higher is preferable, and 250°C or higher is more preferable. As the temperature at which the width direction stretching is performed, 50°C or higher is enough, and 100°C or higher is preferable. Furthermore, in the present step, the temperatures at which these stretchings are performed may exceed the melting point of PTFE. It should be noted, however, that a temperature exceeding the melting point of PTFE makes it difficult to stretch the second sheet in the width direction by a factor as large as 10 or more. Moreover, a temperature exceeding the melting point of PTFE causes a surface of the second porous body to sinter, lowering the water pressure resistance in some cases. Therefore, the temperatures at which the stretchings are performed should be set appropriately based on the desired properties for the porous PTFE membrane.

[0024] In the third step, a laminate is obtained first by pressure-bonding the first porous body manufactured in the first step to the second porous body manufactured in the second step. Specifically, the first porous body is stacked on one side or both sides of the second porous body so that a longitudinal direction of the first porous body conforms to that of the second porous body, and the first and second porous bodies are pressure-bonded to each other by a roll pair composed of a metal roll and a rubber roll. The pressure at which the pressure-bonding is performed is approximately 1 kg/cm² in terms of the air pressure applied on cylinders pressing the rolls. As the rolls, rolls with a diameter of 20 cm can be used, for example.

[0025] The number of the first porous body stacked on one side or both sides of the second porous body may be one, or 2 or more. It may be determined appropriately based on a desired thickness of the porous PTFE membrane.

[0026] The first and second porous bodies do not necessarily have to be pressure-bonded to each other to obtain the laminate. They merely may be stacked, and then stretched in this state in the subsequent step.

[0027] Next, the obtained laminate is stretched at least one time or more in its longitudinal direction, which is the same direction as in the stretching of the first step, while being heated at a temperature equal to or higher than the melting point of PTFE, so that the first and the second porous bodies are integrated with each other. When a plurality of the first porous bodies are stacked on one side of the second porous body, these first porous bodies are also integrated with each other. Thereby, it is possible to obtain the porous PTFE membrane with a high air permeability and water pressure resistance as well as a large thickness, that is, the porous PTFE membrane having a thickness in the range of 70 μm to 400 μm , an air permeability in the range of 2 seconds/100mL to 40 seconds/100mL in terms of Gurley number, and a water pressure resistance in the range of 40 kPa to 300 kPa. In the obtained porous PTFE membrane, the first porous body has a configuration stretched only in the uniaxial direction, and the second porous body has a configuration stretched in the biaxial directions.

[0028] The stretching factor of the laminate can be selected suitably to obtain a target air permeability. Preferably, it is at least 1.1 but not more than 5.

[0029] The heating temperature of the laminate, that is, the temperature at which the laminate is stretched, is not particularly limited as long as it is equal to or higher than the melting point of PTFE. Preferably, it is at least 360°C but not higher than 400°C.

[0030] When a single stretching results in an insufficient bonding strength between the stacked layers, it is preferable to stretch the laminate two times or more. Here, the bonding strength between the layers is regarded as insufficient when each of the layers (the first porous body or the second porous body) is separated at the interface between the layers in an attempt to peel off one of the layers by hand. Thus, the stretching conditions (such as the number of stretchings to be performed) are determined so as to achieve a sufficient bonding strength while avoiding the separation.

[0031] The number of stretchings to be performed in the present step needs to be determined appropriately based on the desired properties of the porous PTFE membrane because an increased number of stretchings enhance the air permeability but on the other hand lower the water pressure resistance.

[0032] The porous PTFE membrane obtained as described above is cut out into a disc shape, for example, to serve as a water-proof air permeable filter for eliminating a pressure difference between the inside and outside of a housing 4, and is welded to the housing 4 so as to close an opening 4a of the housing 4, as shown in Fig. 2A and Fig. 2B. Alternatively, an adhesive layer 3, such as a double-sided tape, may be formed on a peripheral portion of the porous PTFE membrane so that the porous PTFE membrane is bonded to a peripheral portion around the opening 4a via the adhesive layer 3.

EXAMPLES

[0033] Hereinafter, the present invention will be described in detail with reference to Examples, but the present invention is not limited to these Examples.

[0034] The air permeabilities mentioned in the Examples each complies with JIS P 8117 (Gurley method), and denotes a time taken for 100 mL of air to permeate through an object under a constant pressure. A smaller value indicates a higher air permeability. The water pressure resistances comply with JIS L 1092-B (high water pressure method).

(Example 1)

[0035] An unsintered tape-shaped sheet with a thickness of 0.3 mm was produced from CD-145 (with a standard specific gravity of 2.19), which is a PTFE resin produced by Asahi Glass Co., Ltd, by using a common method. The sheet was stretched only uniaxially in its longitudinal direction by a factor of 4 at 280°C. Thus, a first porous body was obtained. The obtained first porous body had a thickness of 170 μm , an air permeability of 18 seconds/100mL, and a water pressure resistance of 70 kPa.

[0036] Next, an unsintered tape-shaped sheet with a thickness of 0.2 mm was produced from F101HE, which is a PTFE resin produced by Daikin Industries Ltd. The sheet was stretched in its longitudinal direction by a factor of 4 at 280°C first, and then stretched in its width direction by a factor of 25 at 130°C. Thus, a second porous body was obtained. The obtained second porous body had a thickness of 15 μm , an air permeability of 2 seconds/100mL, and a water pressure resistance of 420 kPa.

[0037] One first porous body was stacked on each side of the second porous body, respectively, (see Fig. 1B), and then these porous bodies were pressure-bonded to each other by a roll pair, so that a laminate was obtained. In this state, the first porous bodies and the second porous body seemed to be integrated with each other, but they would be separated when peeled off by hand.

[0038] Subsequently, the obtained laminate was stretched in its longitudinal direction by a factor of 2 at a speed that allows the laminate to stay in a furnace set at 380°C for 1 minute or more, so that the first porous bodies and the second porous body were integrated with each other. Thus, a porous PTFE membrane was obtained. The obtained porous PTFE membrane had a thickness of 300 μm , an air permeability of 15 seconds/100mL, and a water pressure resistance of 350 kPa.

(Example 2)

[0039] The porous PTFE membrane obtained in the Example 1 was stretched further by a factor of 1.2 at a speed that allows the porous PTFE membrane to stay in a furnace set at 380°C for 1 minute or more. The finally obtained porous PTFE membrane had a thickness of 300 μm , an air permeability of 10 seconds/100mL, and a water pressure resistance of 250 kPa.

(Example 3)

[0040] An unsintered tape-shaped sheet with a thickness of 0.3 mm was produced from CD1 (with a standard specific gravity of 2.20), which is a PTFE resin produced by Asahi Glass Co., Ltd., by using a common method. The sheet was stretched only uniaxially in its longitudinal direction by a factor of 4 at 280°C. Thus, a first porous body was obtained. The obtained first porous body had a thickness of 170 μm , an air permeability of 10 seconds/100mL, and a water pressure resistance of 40 kPa.

[0041] Next, an unsintered tape-shaped sheet with a thickness of 0.2 mm was produced from F101HE, which is a PTFE resin produced by Daikin Industries Ltd. The sheet was stretched in its longitudinal direction by a factor of 4 at 280°C first, and then stretched in its width direction by a factor of 25 at 130°C. Thus, a second porous body was obtained. The obtained second porous body had a thickness of 15 μm , an air permeability of 2 seconds/100mL, and a water pressure resistance of 420 kPa.

[0042] One first porous body was stacked on each side of the second porous body, respectively, (see Fig. 1B), and then these porous bodies were pressure-bonded to each other by a roll pair, so that a laminate was obtained. In this state, the first porous bodies and the second porous body seemed to be integrated with each other, but they would be separated when peeled off by hand.

[0043] Subsequently, the obtained laminate was stretched in its longitudinal direction by a factor of 2 at a speed that allows the laminate to stay in a furnace set at 380°C for 1 minute or more, so that the first porous bodies and the second porous body were integrated with each other. Thus, a porous PTFE membrane was obtained. The obtained porous PTFE membrane had a thickness of 300 μm , an air permeability of 10 seconds/100mL, and a water pressure resistance of 350 kPa.

(Example 4)

[0044] The porous PTFE membrane obtained in the Example 3 was stretched further by a factor of 1.2 at a speed that allows the porous PTFE membrane to stay in a furnace set at 380°C for 1 minute or more. The finally obtained porous PTFE membrane had a thickness of 300 μm , an air permeability of 5 seconds/100mL, and a water pressure resistance of 250 kPa.

(Example 5)

[0045] The first and second porous bodies were produced as in the Example 3. Two first porous bodies, one second porous body, and one first porous body were stacked in this order (see Fig. 1C), and they were integrated with each other as in the Example 3. Thus, a porous PTFE membrane was obtained. The porous PTFE membrane was stretched again as in the Example 4. The finally obtained porous PTFE membrane had a thickness of 410 μm , an air permeability of 7 seconds/100mL, and a water pressure resistance of 250 kPa.

(Comparative Example 1)

[0046] An unsintered tape-shaped sheet with a thickness of 0.3 mm was produced from F101HE (with a standard specific gravity of 2.143), which is a PTFE resin produced by Daikin Industries Ltd., by using a common method. The sheet was stretched only uniaxially in its longitudinal direction by a factor of 4 at 280°C. Thus, a first porous body was obtained. The obtained first porous body had a thickness of 138 μm , an air permeability of 120 seconds/100mL and a water pressure resistance of 300 kPa.

[0047] Next, an unsintered tape-shaped sheet with a thickness of 0.2 mm was produced from the same resin, F101HE. The sheet was stretched in its longitudinal direction by a factor of 4 at 280°C first, and then stretched in its width direction by a factor of 25 at 130°C. Thus, a second porous body was obtained. The obtained second porous body had a thickness of 15 μm , an air permeability of 2 seconds/100mL, and a water pressure resistance of 420 kPa.

[0048] One first porous body was stacked on each side of the second porous body, respectively, and then these porous bodies were pressure-bonded to each other by a roll pair, so that a laminate was obtained. In this state, the first porous bodies and the second porous body seemed to be integrated with each other, but they would be separated when peeled off by hand.

[0049] Subsequently, the obtained laminate was stretched in its longitudinal direction by a factor of 2 at a speed that allows the laminate to stay in a furnace set at 380°C for 1 minute or more, so that the first porous bodies and the second porous body were integrated with each other. Thus, a porous PTFE membrane was obtained. The obtained porous PTFE membrane had a thickness of 243 μm , an air permeability of 220 seconds/100mL, and a water pressure resistance of 400 kPa.

[0050] The obtained porous PTFE membrane was stretched further by a factor of 1.2 at a speed that allows the porous PTFE membrane to stay in a furnace set at 380°C for 1 minute or more. The finally obtained porous PTFE membrane had a thickness of 240 μm , an air permeability of 211 seconds/100mL and a water pressure resistance of 310 kPa.

(Comparative Example 2)

[0051] A porous PTFE membrane was obtained in the same manner as in the Comparative Example 1, except that the stretching factor in manufacturing the first porous body was 10. The obtained porous PTFE membrane had a thickness of 95 μm , an air permeability of 100 seconds/100mL, and a water pressure resistance of 310 kPa.

(Comparative Example 3)

[0052] A porous PTFE membrane was obtained in the same manner as in the Example 1, except that the temperature at which the integration was performed was 330°C. When an attempt was made to peel off the first porous body of the obtained porous PTFE membrane by hand, the first porous body was separated at an interface between the second porous body and itself.

(Comparison)

Table 1 summarizes property values of the Examples 1 to 5 and Comparative Examples 1 to 3.

[0053]

[Table 1]

	Thickness of porous PTFE membrane (μm)	Air permeability (second/100mL)	Water pressure resistance (kPa)
Example 1	300	15	350
Example 2	300	10	250
Example 3	300	10	350
Example 4	300	5	250
Example 5	410	7	250
C. Example 1	240	211	310
C. Example 2	95	100	310
C. Example 3	—	—	—

[0054] Comparing the Examples 1 to 5 with the Comparative Example 1, it is found that the porous PTFE membrane had a significantly higher air permeability in the Examples 1 to 5, in which the first porous body was produced from a resin with a low molecular weight, than in the Comparative Example 1, in which the first porous body was produced from a resin with a high molecular weight. In addition, it is found that the water pressure resistances were also good in the Examples 1 to 5, maintained relatively high at 250 kPa or 350 kPa.

[0055] The stretching factor in manufacturing the first porous body was 4 in the Comparative Example 1, and it was increased to 10 in the Comparative Example 2. As a result, the air permeability was enhanced but the thickness was reduced in the Comparative Example 2. In contrast, in the Examples 1 to 5, the thickness was increased and the air permeability was enhanced. This means that it is not only difficult to ensure a thickness but also impossible to obtain a sufficient air permeability by merely increasing the stretching factor in manufacturing the first porous body. However, it is possible to ensure the thickness and enhance the air permeability effectively by using a resin with a low molecular weight for producing the first porous body.

[0056] The above-mentioned results reveal that the production method of the present invention makes it possible to obtain a porous PTFE membrane having a high air permeability and water pressure resistance as well as a large thickness by producing the first porous body from a resin with a low molecular weight, in other words, a resin with a standard specific gravity of 2.155 or more.

Claims

1. A method for producing a porous polytetrafluoroethylene membrane, comprising the steps of:

manufacturing a first porous body by stretching, in a uniaxial direction, a sheet made of polytetrafluoroethylene having a standard specific gravity of 2.155 or more;
 manufacturing a second porous body by stretching, in biaxial directions, a sheet made of polytetrafluoroethylene;
 and
 integrating the first porous body with the second porous body by stretching a laminate of the first porous body and the second porous body in the same direction as the uniaxial direction while heating the laminate at a temperature equal to or higher than a melting point of polytetrafluoroethylene.

2. The method for producing the porous polytetrafluoroethylene membrane according to claim 1, wherein in the step of manufacturing the first porous body, the sheet is stretched by a factor of 2 or more at a temperature lower than the melting point of polytetrafluoroethylene.
3. The method for producing the porous polytetrafluoroethylene membrane according to claim 1, wherein in the step of manufacturing the first porous body, the first porous body with a thickness of at least 50 μm but not more than 200 μm is obtained.

4. The method for producing the porous polytetrafluoroethylene membrane according to claim 1, wherein in the step of manufacturing the second porous body, the second porous body with a thickness of at least 10 μm but not more than 100 μm is obtained.

5. A porous polytetrafluoroethylene membrane with a laminated structure, having a thickness in the range of 70 μm to 400 μm , an air permeability in the range of 2 seconds/100mL to 40 seconds/100mL in terms of Gurley number, and a water pressure resistance in the range of 40 kPa to 300 kPa.

6. The porous polytetrafluoroethylene membrane according to claim 5, wherein:

the laminated structure is a structure in which a first porous body and a second porous body are stacked on each other; and

the first porous body has a configuration stretched only in a uniaxial direction, and the second porous body has a configuration stretched in biaxial directions.

7. The porous polytetrafluoroethylene membrane according to claim 6, wherein:

the first porous body is manufactured by stretching a sheet made of polytetrafluoroethylene only in the uniaxial direction, and the first porous body is stretched further only in the uniaxial direction; and

the second porous body is manufactured by stretching a sheet made of polytetrafluoroethylene in the biaxial directions, and the second porous body is stretched further in one of the biaxial directions.

8. A water-proof air permeable filter comprising a porous base material for preventing entry of water while ensuring air permeability,

wherein the base material is composed of the porous polytetrafluoroethylene membrane according to claim 5.

9. The water-proof air permeable filter according to claim 8, further comprising an adhesive layer formed on the porous polytetrafluoroethylene membrane.

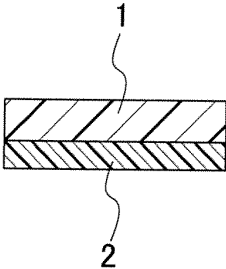


FIG.1A

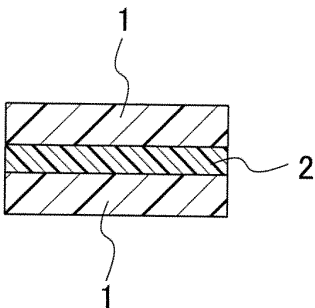


FIG.1B

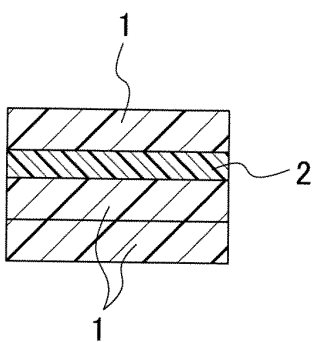


FIG.1C

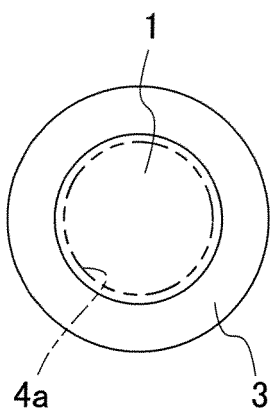


FIG. 2A

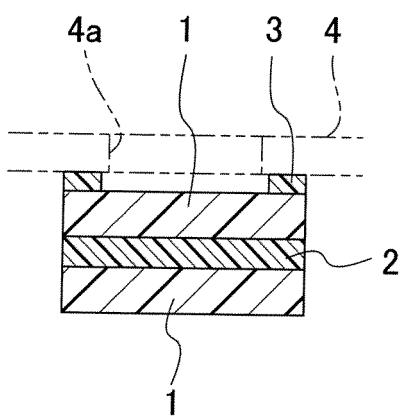


FIG. 2B

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/070509

A. CLASSIFICATION OF SUBJECT MATTER <i>B32B27/30</i> (2006.01)i, <i>B29C55/02</i> (2006.01)i, <i>B32B5/32</i> (2006.01)i, <i>B32B37/16</i> <i>(2006.01)i</i> , <i>C08J9/00</i> (2006.01)i, <i>B29K27/18</i> (2006.01)n, <i>B29K105/04</i> (2006.01)n According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) <i>B32B1/00-43/00</i> , <i>B29C55/02</i> , <i>C08J9/00</i> , <i>B29K27/18</i> , <i>B29K105/04</i> Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009 Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009 Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 55-108425 A (Nitto Electric Industrial Co., Ltd.), 20 August, 1980 (20.08.80), Claims; column 2, line 14; column 5, lines 4 to 8; column 7, lines 10 to 13; column 10, lines 10 to 11; column 11, lines 3 to 5; column 14, lines 2 to 16; column 17, 2nd to 3rd lines from the bottom (Family: none)	1-9
Y	JP 8-174738 A (Sumitomo Electric Industries, Ltd.), 09 July, 1996 (09.07.96), Claims; Par. Nos. [0003], [0019], [0020], [0024], [0030] to [0032] (Family: none)	1-4, 7
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 28 January, 2009 (28.01.09)		Date of mailing of the international search report 10 February, 2009 (10.02.09)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/070509

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-315817 A (Seiren Co., Ltd.), 11 November, 2004 (11.11.04), Par. Nos. [0019], [0020] (Family: none)	5-9
Y	JP 2004-47425 A (Nitto Denko Corp.), 12 February, 2004 (12.02.04), Par. Nos. [0031] to [0034], [0077] & US 2003/0220067 A1 & EP 1363069 A2	5-9
A	JP 8-72178 A (Japan Gore-Tex Inc.), 19 March, 1996 (19.03.96), Par. No. [0014] (Family: none)	1-7
A	JP 5-214140 A (Mitsubishi Kasei Corp.), 24 August, 1993 (24.08.93), Claim 3 & US 5358678 A & US 5510176 A	1-9
A	JP 2005-246233 A (Nitto Denko Corp.), 15 September, 2005 (15.09.05), Claims (Family: none)	1-9

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/070509

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The common matter between the invention of claim 1 and the invention of claim 5 is a matter that the porous polytetrafluoroethylene film has a laminated structure.

However, as a result of the search, it is found that a porous polytetrafluoroethylene film having a laminated structure is not novel, as disclosed in a document: JP 2005-246233 A (Nitto Denko Corp.). Therefore, the common matter cannot be regarded as a special technical feature.

Consequently, it is obvious that the inventions of claims 1 and 5 do not comply with the requirement of unity of invention.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
the

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11058575 A [0003]